

## **ITEM 565.90 10 M VISCOUS FLUID DAMPERS**

### **DESCRIPTION.**

Provide, test and install completed fluid viscous damping devices.

**Work In This Section:** Principal items include:

1. Preparation of shop drawings, test reports, designing, fabrication, testing, handling and shipping to the site.
2. Extent of fabrication of Viscous Damping Devices (VDD) work of this section is indicated by the requirements of this section.
3. Production Dampers: Provide Viscous Damping Devices (dampers), referred to herein as 'Production Dampers' in accordance with the specifications.
4. Installation of dampers shall be according to the Plans and the manufacturer's requirements.

### **MATERIALS.**

Except as specified herein, the materials, parts and processes used in the design and manufacture of the unit shall conform to ASTM, ASTM and ASME standards. All materials and processes used shall be identified in vendor drawings by specifications or standards.

The damper system and components shall be one of the following, or an approved equal:

Taylor Devices, Inc.  
90 Taylor Drive  
North Tonawanda, NY 14120-0748  
Telephone: 716-694-0800  
Facsimile: 716-695-6015

Enidine Incorporated  
7 Centre Drive  
Orchard Park, NY 14127  
Telephone: 716-662-1900  
Facsimile: 716-662-1909

All materials used in the manufacture of the unit shall be subject to approval by the engineer. The vendor may be required to substantiate suitability of the material by furnishing samples or certified test data, or both.

Unless suitably protected against electrolytic corrosion, dissimilar materials shall not be used in contact with each other. Dissimilar metal joints shall not be permitted without a non-metallic separator or gasket of at least .06-inch (1.5mm) thickness. The use of aluminum, aluminum alloys, magnesium, magnesium alloys, beryllium and beryllium alloys is prohibited.

Only non-organic materials shall be used in the unit.

All castings shall be prohibited for pressure vessel parts or any other parts subjected to tensile or bending stresses, except for parts such as covers, handles, etc. whose failure would not affect the

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structural integrity or performance characteristics of the unit. Such casting may be Class 2B, subject to the approval of the engineer.

### **Parts**

**1. VDDs:** VDDs shall be constructed of maintenance-free designs only. Reservoirs, external plumbing and/or fluid level indicators are not permitted.

**2. Age Sensitive Parts:** All non-metallic packings, seals, wipers or gaskets shall be of non-age sensitive materials.

**3. Piston Rods:** Piston rods and any part that slides relative to a seal shall be manufactured from stainless steel only. Plating may be applied over the stainless steel if required by the type of fluid seal selected.

**4. Operating Fluid:** Operating fluid used in the dampers shall be non-toxic and non-flammable. Petro-chemical fluids shall not be used.

**5. Pressure Vessels:** The components of the damper that are pressure vessels are to be of non-tie rod type construction, without externally supported heads or end caps. Welded construction or castings of any type are not permitted for pressure vessel construction.

**6. Seals:** Pressure vessels and seals shall be rated for 137.9 MPa minimum burst pressure. A randomly selected production unit shall be tested to this pressure, with no loss of fluid or parts failure of any type permitted.

**7. Parts List Approval:** The vendor shall submit the equipment parts list for review and approval by the engineer. Approval will be based on an evaluation of the following documentation as applicable to each part.

- A. Vendor part number and nomenclature
- B. Military or other applicable specifications
- C. Source name and part number
- D. Testing and inspection requirements

### **CONSTRUCTION DETAILS.**

**References:** Conform to the applicable provisions of the current editions of the following standards, except as indicated otherwise on the drawings or the specifications:

1. ASTM E4 - Load Verification of Testing Machines
2. ASTM A36 - Specification for Structural Steel
3. ASTM A325 - Specification for High Strength Steel Bolts
4. ASTM A570 - Specification for Structural Sheet Steel
5. AWS D1.1 - Structural Welding Code of the American Welding Society
6. ISO 9001:2000 - Model for Quality Assurance
7. AISC 'Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings', by the American Institute of Steel Construction
8. AISC 'Code of Standard Practice for Steel Buildings and Bridges'
9. SSPC 'Steel Structures Painting Council'

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NOTE: Proposed alternate standards shall be submitted to the engineer for review and approval.

### **Submittals:**

**1. General:** All submittals shall be made as directed by the engineer.

**2. Prequalification Requirements:** VDD manufacturers must submit the following test reports for qualification to bid. These reports must be submitted to the engineer for review.

A. A published test report showing the dynamic characteristics of the proposed VDDs. This report shall include force-displacement and force-velocity plots and shall be used to demonstrate the independence of the proposed VDDs to temperature, frequency and cyclic degradation.

B. A list of five or more projects where VDDs have been installed in a structure for seismic protection. For each project, the VDDs shall have provided a minimum of one-year satisfactory service.

**3. Shop Drawings:** Shop Drawings shall include, but shall not be limited to, installation drawings, setting diagrams, and bolting templates. Submit Shop Drawings for:

A. Each and every VDD type indicating dimensions and weights. Submit prior to delivery.

B. All steel mounting and connecting hardware, which is integral with the VDD.

### **4. Product Data:**

A. VDD: Product Data shall include, but shall not be limited to manufacturer's product specifications, a list of production history for seismic dampers, and installation instructions.

B. Paint: Submit manufacturer's literature and data.

**5. Certifications:** Submit the following documents, written and signed by an independent testing agency, to be approved by the engineer.

A. Certification that all testing equipment has been checked for accuracy by appropriate standards for the purpose of this specification.

B. Certified mill test reports for all steel to be used.

**6. Inspection And Test Reports:** Submit the following test reports, written and signed by an independent testing agency, to be approved by the engineer.

A. Production VDD Test Reports: Submit test data for each production VDD within fourteen (14) calendar days after the completion of testing of the subject VDD.

B. Final VDD Test Report: Submit the Final VDD Report, as described in this Section, within twenty-eight (28) calendar days after the completion of all production VDD testing.

**7. Proposed Test Procedures:** Submit annotated and drafted illustrations of all proposed test apparatus and procedures for tests required by this Section. Such illustrations shall be submitted and approved by the engineer and/or architect prior to the commencement of any testing.

### **Delivery, Storage And Handling:**

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**1. Delivery:** Deliver production VDDs to the job site in protective packaging for freight and handling purposes.

**2. Handling:** Handle VDDs and components carefully to prevent damage, breaking, denting or scoring. Do not deliver damaged VDDs or components; replace with new.

**3. Storage:** Store VDDs in a clean place. Protect from dirt, fumes, construction debris and physical damage.

**Warranties And Guarantees:** A written warranty of the design, workmanship, materials, and performance of the damper units of not less than 35 years shall be provided with the cost proposal. The manufacturer of the VDDs specified herein shall have manufactured VDDs of more than 667 kN output.

### **Quality Assurance:**

**1. Product Quality Control:** To ensure effective control over product quality, the vendor shall establish and maintain a manufacturing/processing control system including written process specifications and procedures to insure that manufacturing, processing, inspection and testing are accomplished in accordance with Control of Quality, ISO 9001.

The seller shall provide and maintain a system that complies with the requirements of the International Standard Organization (ISO) 9001 model for quality assurance in design, development, production, testing, installation and servicing.

**2. Manufacturing Process Control:** In addition to compliance with the quality assurance system, the vendor must maintain a system for manufacturing process control of this project, which includes as a minimum the following:

1. Raw Material Traceability.
2. Specific Raw Material Traceability.
3. Special Process Certification Traceability.
4. Detailed manufacturing instructions that identify by operation and machine the work performed.
5. Inspection instructions.
6. In process and final detail component inspection instruction with actual dimensions.

**3. Part Information:** Specific instructions for detail part marking providing for one way backward traceability to the information listed in paragraph 2 (Manufacturing Process Control) shall be provided by the contractor. This information shall be readily retrievable and shall be combined into one inclusive document that is controlled and approved by quality assurance personnel at the contractor's facility.

**4. Calibration System Requirements:** All devices used to measure, gage, test, inspect or otherwise examine items to determine compliance with specification and/or contractual requirements shall be calibrated in compliance to a calibrated measurement standard which has known valid relationships traceable to the National Institute of Standards and Technology (NIST), or approved equivalent.

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### **Fabrication**

#### ***1. Processes***

A. Protective Treatment: Materials subject to deterioration when exposed to environmental conditions likely to occur during service usage, shall be protected against such deterioration in a manner that will in no way prevent compliance with the requirements of this specification. The use of any protective coating that will crack, chip or scale with age or extremes of climate and environmental conditions shall be avoided. Corrosion control shall be used as a guide for minimizing corrosion damage to the assembly.

B. Fusion Welding: Fusion welding shall be in accordance with approved standards and procedures. Weld design shall be based on the function and strength of the assemblies. Fillet welds on plate above 3.2mm thickness will not be used on primary structures without specific approval by the engineer. Weld quality shall be specified on vendor drawings with proper acceptance standards and inspection methods.

C. Soldering: Soldering shall be in accordance with approved standards and procedures. Whenever insulation material is subject to heating during soldering, the material shall be undamaged and parts fastened thereto shall not be loosened. No mechanical assembly shall depend on soft-solder for mechanical strength.

D. Finish: The exterior finish of the unit, including the color and finish type required shall be recommended by the vendor and submitted to the engineer for approval.

***2. Workmanship:*** The unit, including all parts and accessories, shall be constructed and finished in a thoroughly workmanlike manner. Particular attention shall be given to neatness and thoroughness of soldering, wiring, making of parts and assemblies, welding, brazing, plating, finishes, riveting, machining and screw assemblies. All parts shall be free of burrs and sharp edges and any damage, defect or foreign material, which might detract from the intended operation, function or appearance of the unit.

**Safety:** The design of the unit shall be such that all possible sources of danger to personnel or equipment during assembly, disassembly, testing, operation and maintenance are removed. Any precautionary measures shall be prominently and clearly indicated on the equipment.

**Maintainability:** The unit shall be constructed to be maintenance free. The use of reservoirs, external plumbing and/or fluid level indicators shall not be permitted. Each VDD shall be designed and constructed such that installation, removal and replacement, if necessary, shall be a simple process not requiring any special tools or methods.

**Interchangeability:** All parts having the same manufacturer's part number shall be functionally and physically interchangeable. The vendor shall assign new part numbers when change numbers cause any of the following conditions:

1. Performance or durability is affected to such an extent that superseded items must be discarded for reasons of safety or malfunctioning.
2. Parts, subassemblies of complete units are changed to such an extent that the superseded and superseding items are not interchangeable.

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3. Superseded parts are limited to use in specific articles or models of articles and the superseding parts are not so limited to use.

When interchangeable repairable assemblies contain a non-interchangeable part, the part number re-identification of the non-interchangeable part, of it next assembly and all the progressive higher assemblies shall be changed up to and including the assembly where the interchangeability is re-established.

**Change Control:** After initial design completion and approval, any change or substitution of material, dimensions, processes or other characteristics must be tested as per this specification. Following the required testing, the engineer must approve the substitution prior to incorporation. The vendor shall exercise the same configuration control over his suppliers.

**Identification Marking:** Units, subassemblies and parts shall be marked for identification in accordance with the manufacturer's standard practice.

**Serial Number Assignment:** Sequential serial numbers shall be assigned to all units in accordance with the architect and/or engineer's requirements. The individual number shall be assigned according to the vendor's standard practice unless otherwise specified in the purchase order or contract.

### **Detail And Technical Requirements**

**1. Function:** The VDDs shall provide an output force in either tension or compression that is directly proportional to the relative velocity between the two ends of the dampers. The damper output force varies only with velocity, and does not change with damper stroke position or orientation angle. The function of the dampers is to absorb earthquake energy, thereby reducing or eliminating damage to the building when an earthquake occurs.

**2. Fluid Medium:** The unit shall use inert silicone fluid as the operating fluid medium.

**3. Fluid Expansion Compensation:** The unit shall contain provisions to allow for thermal expansion and contraction of the fluid medium to prevent excessive buildup of internal high pressure or vacuum pressure.

**4. Servicing Provisions:** The VDD unit shall be designed and constructed to be maintenance free for the expected life of the VDD.

**5. Adjustment:** The unit shall be designed to provide for a length adjustment of plus or minus 6.4mm.

**6. Dimensions:** The overall dimensions of the unit shall be held to a minimum consistent with the requirements of this specification, and in no case shall they exceed the dimensions specified in the Plans.

### **Construction**

**1. General:** The VDD unit shall be of corrosion-protected construction with stainless steel piston rod internally mounted.

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### **2. Design Loads**

**A. Axial Design Load:** The maximum axial design load shall be 2000kN tension or compression with the rod fully extended, retracted or at any intermediate point.

**B. Lateral Design Loads:** The unit shall be designed to withstand a lateral acceleration of 1 g in any direction in any position of rod extension/retraction.

**C. Fluid Pressure:** The unit shall be designed to withstand the following internal pressure:

1. Proof: 200 percent of maximum operating pressure.
2. Burst: 300 percent of maximum operating pressure, but not less than 137.9 MPa.

**D. Factors of Safety:** Minimum factors of safety for the unit shall be 2.0 limit and 2.5 ultimate. The unit shall be such that no yielding will result from the application of limit loads and no failure will result from application of ultimate loads. Limit and ultimate loads shall include the effects of load factors included herein.

### **Performance**

**1. Damping Coefficient:** The unit shall operate with a damping coefficient in both directions of travel as shown in the Plans.

**2. Duty Cycles:** The unit shall be designed to the amplitude, frequency and time requirements of the following wind load and seismic loading duty cycles.

**A. Wind Load Duty Cycle:** 0 to 6.4mm amplitude at 1 cps for 300,000 cycles per year.

**B. Seismic Loading Duty Cycle:** 25.4mm mean amplitude (50.8mm peak amplitude) at 0.75 cps for 5 cycles (average) per year.

**3. Maximum/Minimum Operating Temperatures:** The unit shall be capable of operating at the energy levels, time and the environmental conditions specified herein, without degradation of performance or life as a result of maximum/minimum operating temperature.

**4. Leakage:** The unit shall not leak the operating fluid externally under any circumstances whether under operating or non-operating conditions. When subjected to proof pressure for two (2) minutes, the unit shall show no visible evidence of external leakage.

**5. Stroke:** The unit shall be capable of meeting the performance requirements of this specification, when cycled about any point within the full stroke of the unit.

**6. Life:** The unit shall be designed to guarantee a minimum reuse of one maximum capable seismic event before requiring refurbishment.

### **Environmental Conditions**

**1. Ambient Operating Temperature:** When installed, the unit shall be capable of operating in an ambient air temperature from -7 degrees C to +54 degrees C.

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**2. Atmospheric Pressure:** The unit shall operate at essentially sea level pressure (760 50mm mercury).

**3. Humidity:** The unit shall be designed to withstand relative humidity up to 100 percent, including condensation due to temperature change.

**4. Other Atmospheric Elements:** The unit shall be designed to withstand any of the probable combinations of the following atmospheric elements: rain, snow, sleet, hail, ice, fog, smoke, wind, ozone, sunshine, sand and dust, and salt atmosphere.

### **Testing Of Viscous Damping Device Units**

#### **1. Production Unit Testing:**

**A. Purpose:** Production unit testing shall be conducted in order to verify the following:

1. The general quality and manufacturing consistency of each of the production units.
2. The general consistency of all production units in terms of their performance characteristics to meet the requirements of the contract documents.

#### **B. Acceptance Criteria:**

1. No visible leakage or signs of physical deterioration or degradation in performance shall be observed during and after the series of tests. There shall be no signs of yielding or permanent deformation, or re-torquing of parts.
2. The force-velocity results from the tests both in tension and in compression, adjusted for expected variations due to temperature and number of stroke cycles shall fall entirely within +/- 10% of  $F = cV^a$

#### **2. Sequence of Testing:**

**A. Quality Assurance Tests:** Production units shall be subjected to and pass the following sequence of quality assurance tests:

1) Proof load test: An internal pressure shall be applied to each VDD that shall be equivalent to 125% of the maximum damper load (each production unit). This pressure shall be maintained for 120 seconds.

2) One out of every production units, or a minimum of two (2) units, shall be cycled through its full end-to-end displacement for a total of 120 cycles. The cyclic velocity is expected to be much slower than the design maximum velocity and shall depend on the capacity of the approved testing apparatus.

**B. Performance Verification Tests:** Each production unit shall be tested for performance verification as follows:

1) Compression Testing: Utilizing a hydraulic actuator, or a heavy weight drop hammer set-up, the unit shall be tested in compression at 100% of the damper

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design velocity as determined from dynamic analysis of the structure. The force, displacement and time measurements shall be accurately obtained and recorded. Force-velocity plots shall be constructed from this data.

2) Tension Testing: The same sequence of tests as for compression testing shall be conducted with the unit responding in tension (extension). The data shall be recorded and plotted as above.

3) For time/cost savings, testing in the compression direction only may be proposed, provided the damper manufacturer can substantiate the balanced nature of fluid orificing in each direction. The use of valves and/or accumulators is not considered a balanced method and will require testing in both directions.

### **Installation Of Viscous Damping Device Units**

The viscous damping devices, including all plates, brackets and anchor bolts (unless otherwise noted), shall be installed by the Contractor as per the manufacturer's recommendations and as shown on the Plans.

### **METHOD OF MEASUREMENT.**

The quantity to be paid for will be the number of viscous damping devices furnished, tested and installed by the Contractor as shown in the Plans and to the satisfaction of the Engineer.

### **BASIS OF PAYMENT.**

The unit price bid per damper shall include the cost of all labor, materials, installation, equipment and testing necessary to complete the work.